June 24, 2002

To: Sarah R. Thomas, Administrative Law Judge, CPUC

From: Snuller Price, Partner, Energy and Environmental Economics Inc.

Re: Rulemaking 01-08-028, Provision of EM&V Services

This submittal is in response to the Rulemaking 01-08-028 Administrative Law Judge's Ruling Regarding Evaluation, Measurement, and Verification of Local Energy Efficiency Programs you issued on June 17, 2002. My firm, Energy and Environmental Economics, Inc. (E3, Inc.) is interested in providing Energy Measurement and Verification (EM&V) services.

Please find attached the requested materials for our submission;

- Energy and Environmental Economics, Inc. Firm Qualifications, Firm Resume, and Areas of Expertise
- Resumes for all persons who will supervise work on an EM&V project; CK Woo, Snuller Price, Brian Horii, and Rouslan Karimov

In addition, there is no potential conflict of interest for the involvement of E3, Inc. in performing these services. We submit the following responses to the specific questions raised in the Ruling;

Idenfication of the Recipient and local energy efficiency program for which the Contractor proposes to perform EM&V services;
We plan to provide EM&V services for the programs that Xenergy is conducting.

An explanation of why the Contractor is independent of Recipient;
E3 has never worked on a project with Xenergy, nor do we perform the local energy efficiency implementation and program management services that Xenergy provides. E3 is a well respected economics and engineering firm specializing in program design, integrated resource planning, and regulatory analysis. Our work often involves the evaluation of DSM programs and statistical load research required to provide EM&V analysis because we are in a related field, but we have no conflict of interest with Xenergy.

A list of all work the Contractor has done with or for the Recipient;
E3 has never worked with or for Xenergy.

An explanation of any factor that might lead a reasonable person to question whether the Contractor is actually independent of the Recipient;
There are no such factors.

A description of any reason why the Commission might not select the Contractor.
There is no reason why the commission might no select E3 as a Contractor.

Thank you very much. Sincerely,

Snuller Price, Partner
Energy and Environmental Economics, Inc.

Attachments; E3 Firm Qualifications - E3 Resumes

Energy and Environmental Economics, Inc.
Corporate Qualifications

INTRODUCTION

Energy and Environmental Economics, Inc. (E3) is a San Francisco based engineering and economics consulting firm specializing in strategic planning for public and private electric utilities and their customers. Founded in 1989, E3 is built upon the partners' extensive experience in resource planning, load research and estimation, distributed generation analysis, electricity pricing, rate design, and financial evaluation. E3 complements its comprehensive knowledge of the industry's business practices with state of the art analysis techniques, as demonstrated by its software development and extensive publications in scholarly journals in the fields of engineering, economics, and finance.

E3 is a well-established firm with dozens of major public and private utility clients throughout the United States and Canada, including PG&E, and additional clients in Central and South America, Europe, Asia, Africa and the Middle East. Non-utility clients include GGNPA, City of San Francisco, NREL, EPRI, DOE, USAID, World Bank, the Utility Photovoltaic Group (UPVG), municipal utilities, non-profit organizations, and a host of commercial energy customers.

The following summarizes E3's key project experience in core areas of our analysis. Important findings from these projects appear in scholarly journals and research reports and have been formally filed in regulatory proceedings in several jurisdictions in the U.S. and Canada.

MEASUREMENT AND EVALUATION

In the last 10 years, Energy and Environmental Economics, Inc. has performed dozens of analyses using statistical load research analysis to determine the impact of DSM and TOU rate structures. For example, in 1999 E3 performed detailed analysis on the load impact of a voluntary Time-Of-Use rate pilot for 650 customers in Laredo, TX using SAS statistical load research analysis. This program involved the installation of 350 'Smart' meters that could receive dispatch signals from the utility, and could be programmed to control appliances based on energy price. The study measured the demand response to the program and customer bill savings and provided a statistical estimation that controled for weather, home size, and other factors. The following publications provide a reference for this body of work.

Hartway, R., S. Price and C.K. Woo (1999) "Smart Meters, Customer Choice and Profitable Time of Use Rate Option," Energy - The International Journal, 24, 895-903.

Woo, C.K., P. Hanser and N. Toyama (1986) "Estimating Hourly Electric Load with Generalized Least Squares Procedures," Energy Journal, 7:2, 153-170.

Woo, C.K. (1985) "Demand for Electricity of Small Nonresidential Customers under Time-of-Use Pricing," Energy Journal, 6:4, 115-127.

Woo, C.K. (1984) "A Note on Measuring Household Welfare Effects of Time-of-Use Pricing," Energy Journal, 5:3, 171-181.

Pupp, R., C.K.Woo, R. Orans, B. Horii and G. Heffner (1995) "Load Research and Integrated Local T&D Planning," Energy - The International Journal, 20:2, 89-94.

Orans, R., C.K. Woo, J.N. Swisher, B. Wiersma and B. Horii (1992) Targeting DSM for Transmission and Distribution Benefits: A Case Study of PG&E's Delta District, Report No. TR-100487, Electric Power Research Institute.
Heffner, G., R. Orans, C.K. Woo, B. Horii and R. Pupp (1993) "Estimating Area Load and DSM Impact by Customer Class and End-Use," Western Load Research Association Conference, September 22-24, San Diego, California; and Electric Power Research Institute CEED Conference, October 27-29, St. Louis, Missouri.

Woo, C.K., B.M. Gray and M.E. Carl (1987) "Residential Air Conditioning Load Model," 8th International Association of Energy Economists (IAEE) Conference, MIT.

ENERGY TECHNOLOGY ASSESSMENT

E3 and its staff have been involved in numerous specific and broad technology assessment projects for NREL, EPRI, DOE, the Utility Photovoltaic Group (UPVG), utilities, and state and government agencies, among others. E3 has performed technology assessments of currently available renewable and conventional technologies that can be used in distributed applications. In addition to the projects listed here that explicitly focus on technology assessment, E3's numerous LIRP studies performed since the formation of the company have required the staff to continually monitor existing and new technology cost, operation, and dispatch characteristics.

- **Golden Gate National Parks Association (GGNPA)**: 1999-Present. E3 has worked closely with the GGNPA in cooperation with the National Park Service to clearly define technology alternatives for potential onsite sustainability demonstration projects and interpretive programs as well as potential funding sources for leveraging Fort Baker resources for both its upper management and for potential developers.
- **Oklahoma Municipal Power Authority (OMPA)**: 2000. E3, in collaboration with Gridwise Engineering and Endecon Engineering, recently completed a distributed generation engineering study for the OMPA on behalf of its over 30 member municipal utilities. The technlogy assessment portion of the study addressed (1) conventional DG technologies (diesel and spark ignition engines, mini and micro turbines), (2) renewable and advanced generation (photovoltaics, solar thermal electric, wind, battery energy storage and fuel cells), and (3) implementation issues. DG results included generator efficiency and performance characteristics (heat rates, unforced outage rates, size ranges, start-up time, reject heat temperatures, fuel requirements, maintenance and overhaul schedules, emissions characteristics, and interconnection requirements), and costs (capital, installation, operation, and permitting). Renewable energy generation performance and costs were modeled for several sites within the OMPA service area. Several key pragmatic distributed generation implementation issues were reviewed, including evaluation of OMPA's

current capacity purchase contract for use with DG, related rate and tariff issues, interconnection requirements and issues, along with methods for selecting sites for DG.

- **Pacific Gas and Electric Company (PG&E):** 1997-1998. PG&E retained E3 to conduct evaluations of all emerging distributed generation technologies and assess their economic and technical viability in the California market during and after the CTC transition period. E3 evaluated generation from the "customer-side side of the fence" perspective, covering such issues as the impact of the rate form for utility stand-by charges, customer access to natural gas at wholesale or retail rates, and the rate structure's impact on customer incentives to bypass the T&D system.
- **Utility Photovoltaic Group (UPVG):** 1998. E3 was retained by the UPVG to update a working computer database of grid-connected and representative off-grid PV systems in the United States. An E3 staff member developed the original database in 1994. The database contains extensive information on the statistics, costs, performance, motivations, applications, and operating experiences of the PV systems. A significant portion of the updated database concentrates on UPVG Team-Up and SMUD installations in California.
- **PG&E System Testing:** 1996-1997. E3 consulted to PG&E's Research and Development Department on several advanced power conversion and storage technologies. The work included serving on technological review groups, developing extensive test plans, and supervising the testing of the technologies. These technologies included: PQ-2000, a 2 MW, 10-second uninterruptible power supply designed for customer and utility applications; PM-250, a battery storage system designed for load peak-shaving and for hybrid operation with photovoltaics; Wavedriver, a power converter technology designed for cross-application modularity, with potential uses for wind, PV, fuel cell, and battery systems; ASC, a cryogenically cooled power converter technology designed to provide high power conversion in a small volume package.
- **EPRI:** 1997 This project focused on the research analysis and design of alternative energy technology options for office buildings. Reference publication: *Office Complex Guidebook: Innovative Electric Equipment and Solutions*, by J. Swisher, Electric Power Research Inst., EPRI TR-109450, December 1997.
- **EPRI:** 1996 In a related project, this study focused on the design of alternative energy technology options for schools and universities. Reference publication: *Educational Facilities Guidebook: Innovative Electric Solutions*, by J. Swisher, Electric Power Research Inst., EPRI TR-107123, December 1996.

RESOURCE PLANNING

Over the past decade, E3 has led numerous local integrated resource planning (LIRP) studies that identify and evaluate cost-effective applications of small scale generation and demand-side management (DSM) technologies on T&D systems. E3 has also developed several planning software products to help utility planners compare the profitability and risk of alternative plans, and has formed a cooperative alliance with Electrotek Concepts, Inc. to further the development and application of T&D system planning tools. These analytical tools have been jointly developed, documented and tested by E3, EPRI, and numerous utilities:

- The Area Investment Model (AIM) evaluates the profitability and risk associated with alternative T&D plans under uncertain load growth.
- The Engineering Design and Costing Model (EDC) constructs, performs technical analyses, and determines least-cost expansion plans combining traditional T&D investments with distributed generation alternatives, including renewables.
- The Delta model dynamically integrates DR technologies and DSM into existing plans using local area and time specific marginal costing methodology.
- The Remote Power Systems Applications Model (RPAM) helps utility distribution planners and engineers compare the economics of remote renewable hybrid power systems with those of conventional line extensions.

- **PG&E:** (1999-Present). E3 was retained by PG&E to perform a major study evaluating the technical requirements and economic viability of using distributed resources (DR) to offset the need for a contentious high voltage transmission expansion plan.
- **Puget Sound Energy (PSE):** (1999-Present). E3 is currently assisting PSE with the development and implementation of an integrated gas and electric planning process that best satisfies customer expectations, system reliability needs, and corporate financial strategies. The new planning process incorporates a multi-tiered set of screens for potential capital and O&M projects to more efficiently direct scarce planning resources toward areas with high potential for cost-saving expansion alternatives. E3 is also helping Puget refine their local-area load forecasting methodology and implement a probabilistic risk-based approach to their capacity planning procedures.
- **Orange and Rockland Utilities:** (1998-Present). E3 is under contract with ORU to evaluate numerous T&D expansion plans and to provide due diligence analyses of DR-based alternatives. E3 helped ORU develop a multi-stage screening process that efficiently identifies areas with high economic and technical potential for DR solutions so that limited planning resources can be used most effectively.
- **Consolidated Edison (ConEd):** (1999-Present). E3 is working with ConEd to evaluate and provide due diligence analysis of distributed generation and energy efficiency alternatives to T&D expansion plans in the Manhattan area. The analysis extends the DR and DSM screening process to incorporate service reliability considerations for electricity delivery planning.
- **The Energy Foundation**: 2000. E3 worked with Pacific Energy Associates of Portland, Oregon to assemble a summary of common and best practices for costing methodology for electric distribution system planning. The final report was presented to the annual meeting of the National Association of Regulatory Utility Commissioners (NARUC) Committee on Energy and Resources and the Environment on November 12, 2000.
- **EPRI:** 1997-1998. E3 was a subcontractor for an EPRI project on Power Quality Planning. E3 developed insurance-based pricing mechanisms for premium power quality services that incorporate an understanding of customer outage costs, targeted technological solutions, and financial incentives for the customer and utility.

- **TVA:** 1995-1996. E3 was the prime contractor in an EPRI-TVA project to study the feasibility of distributed generation resources, including renewables, as an alternative to transmission and distribution expansion plans for the Tennessee Valley Authority, Nashville Electric Service, and Memphis Light, Gas & Water.
- **Centerior:** 1996. E3 was retained by Centerior to perform an independent review of their proposed transmission expansion. The report showed that the cost of lower reliability imposed on customers from delaying the project far outweighed any benefits of targeted demand side management or distributed resources for the area. Centerior is now in the process of constructing the transmission project. E3 has performed similar reviews for Commonwealth Edison and New York Service Electric and Gas.
- **EPRI**: 1992-1998. E3 has been EPRI's primary contractor for integrated resource planning. E3 developed many of the EPRI methodologies and has performed numerous case studies. These case studies demonstrate that strategically placing distributed resources (i.e., distributed generation and DSM) on a utility's grid can be much more cost-effective and profitable than a system-wide implementation.
- **EPRI:** 1996. E3 customized its integrated planning models for Niagara Mohawk to allow NIMO to evaluate the cost effectiveness of Photovoltaic Grid Connected applications across all of NIMO's service areas. At the time, NIMO was actively promoting PV applications, and E3's model allowed NIMO to prioritize PV installation according to the variations in local weather patterns and transmission and distribution avoided costs.
- **EPRI/PG&E:** 1994-1996. E3 prepared the 1996 report *Distributed Utility Penetration Study*, Report No. TR-106265, Electric Power Research Institute. This report addressed the question of whether distribution load-growth related investment expenditures can be reduced or deferred by clipping peak loads in distribution planning areas. The objective was to estimate the achievable savings from targeting DSM, direct load control programs, and distributed generation to these capacity constrained distribution planning areas.
- **EPRI/NREL/PG&E:** 1993. E3 was a major contributor to the1993 report *Distributed Utility Valuation Project*, EPRI Report No. TR-102807. The purpose of the report was to describe the Distributed Utility concept and discuss the relevant research on the subject.
- **Ontario Hydro (Canada):** 1995. Ontario Hydro hired E3 to extend the local integrated resource planning framework and models to investigate various alternatives for meeting expected load growth in the City of Toronto. The results of the study showed the applicability of the local integrated resource planning framework to larger generation facilities (100MW) and demonstrated its value to bulk system planning.

BUSINESS STRATEGY AND FINANCE

E3's understanding of the market for electric services, its understanding of customer considerations in electricity purchasing decisions, and its understanding of the electricity products being offered by utilities and Energy Service Providers in California offers a unique resource in assessing, evaluating and improving the effectiveness of City power project developments. Recent clients include:

- **Hawaiian Electric Company (HECO)** (2001-Present). E3 has developed a financial pro-forma tool for distributed generation applications from a utility perspective. The analysis incorporates a comprehensive view of project economics including a utility perspective that includes avoided energy purchases, and deferral of T&D capital projects, as well as societal and DG owner perspectives. The tool is designed to facilitate decision-making and provide analysts the necessary information to explain power project development decisions.
- **City of San Francisco** (1999): E3 was a subcontractor to Grueneich Resource Advocates for work with the City to evaluate the market viability of a proposed San Francisco Airport power development. E3 reviewed the finance and forecast methodology employed, and provided analysis of important contract terms, forecasts, and methodology. The analysis included an assessment of the California market structure including the ISO and PX markets.
- **Golden Gate National Parks Association (GGNPA)**: 1999-2001. E3 has worked closely with the GGNPA/NPS project team to develop an overall energy systems plan in light of the sustainability objectives and tight budget. Key strategic issues include developing sustainability standards for potential developers, evaluating opportunities for green power procurements in the context of federal procurement regulations, evaluation of overall energy management system alternatives, describing technology alternatives for potential onsite sustainability demonstration projects and interpretive programs, identifying potential funding sources for leveraging Fort Baker resources, and evaluating alternative business arrangements and operating strategies for upgrading, operating and maintaining the energy distribution and delivery systems.
- **Upper Canada Energy Alliance (UCEA):** 1997-Present. This group of 10 Municipal Electric Utilities has joined together into an organization constituting the 3rd largest electrical load in Ontario, Canada. E3 was retained to develop the strategy and manage the procurement of energy for this group as well as to assist in the development of their jointly owned competitive retail services company.
- **Oklahoma Municipal Power Authority (OMPA)**: 2000. E3, in collaboration with Gridwise Engineering and Endecon Engineering, recently completed a distributed generation engineering study for the OMPA on behalf of its over 30 member municipal utilities. The study evaluated the potential for deploying DG in the OMPA service territories, and explored the development of green power programs for its members' retail customers, including the potential to develop renewable resources to provide power for such programs. The strategic business planning portion of the study addressed economic and technical performance of conventional and renewable DG technologies and potential retail green power product offerings that could be implemented by OMPA and its members, along with an implementation plan . Several key pragmatic distributed generation implementation issues were reviewed, including evaluation of OMPA's current capacity purchase contract for use with DG, related rate and tariff issues, interconnection requirements and issues, along with methods for selecting sites for DG.

- **Newmarket Hydro:** 1998-Present. E3 was retained by Newmarket, an Ontario Municipal Utility, to develop their corporate business strategy under deregulation, including development of new competitive business opportunities, acquisition of strategic wires assets, as well as extending to the regulated business.
- **Puget Sound Energy (PSE):** 1998-Present. E3 is currently advising Puget on positioning their organization to compete in a fast deregulating world by integrating their business and regulatory strategies and planning processes.
- **Corporate Clients (Confidential)**: 1996-Present. E3 has advised these clients on issues ranging from selecting a competitive power provider (at significant discounts) to evaluating their load and energy strategy, or even responding to power marketing contract offerings. Clients have ranged from large telecommunications providers to international energy companies, and top tier hotel owner/management companies.
- **Hawaiian Electric Company (HECO):** 1997-1999. HECO retained E3 to develop a business plan for an unregulated subsidiary company concentrating on hybrid photovoltaic systems and related products for off-grid residential applications. The plan was ultimately approved and financed by the utility's holding company. E3 has also advised HECO's management on best business strategies for restructuring the company and management of its own generation assets and purchases from IPPs. E3 was also retained by HECO to analyze the profitability of its customers. The findings from this analysis are used to formulate HECO's strategies in response to deregulation and potential competition.
- **PG&E Energy Services (PGEES):** 1997–present. PG&E's unregulated subsidiary retained E3 to evaluate the impact of the California Assembly Bill 1890 on PG&E and Southern California Edison utilities. E3 also provides PGEES guidance regarding pricing strategies and market segments to pursue in the deregulated California market.
- **Pacific Gas and Electric Company (PG&E):** 1997-1998. PG&E retained E3 to evaluate the impact of market restructuring in California on the economic viability of renewable and conventional distributed generation technologies. In addition, E3 evaluated the role that these technologies could play as bypass options to transmission and distribution expansion and upgrade. E3's results were presented to the PG&E management committee, and E3 continues to work with PG&E's corporate planning department on related issues.
- **B.C. Hydro (Canada):** 1995-1997. In preparation for emerging competition, B.C. Hydro retained E3 to design rate options to better serve diverse customer needs. The findings were filed with the BCUC that adopted B.C. Hydro's proposals without modification.
- **Ontario Hydro (Canada):** 1998 – present. E3 provided training to Ontario Hydro's staff on a wide variety of complex competitive markets issues including risk management and wholesale trading, transmission pricing and FERC, supply procurement, market structures, competitive intelligence techniques, value of customer information, customer procurement strategies as well as other topics. E3 is currently advising Ontario Hydro on the development of their marketing organization and related products and services.

REGULATORY ANALYSIS AND REQUIREMENTS

E3 provides expert opinions on pricing, regulation, marginal costing, resource planning and asset evaluation for electric utilities. E3 professionals have testified before public utilities commissions in the U.S. and Canada on such matters as market restructuring, asset evaluation, rate design, wheeling, marginal costing, and resource planning. E3's recent engagements entail analyzing the potential effects of market restructuring on customer bills and utility stranded costs; the company is directly involved in the ongoing market restructuring analyses in California and Texas, and in Ontario and British Columbia in Canada.

Regulatory Analysis and Requirements

Ren Orans, C.K. Woo and Brian Horii lead E3's litigation and regulatory support practice. With over 60 years of combined experience in the electric industry, we are recognized experts in the specific regulatory issues and applied economic solutions of concern to our clients. We have testified in numerous regulatory proceedings in California, Texas, British Columbia, Ontario and Quebec and have maintained ongoing client relationships with utilities in North America, Hong Kong and Israel.

Retained by the counsel or senior management of our clients, we offer expert opinions on industry issues such as general rate case proceedings, market reform strategies, stranded cost recovery, transmission access and pricing, regional transmission organization development, resource planning, cost allocation and recovery, rate design, and performance-based-regulation. We form our opinions based on sound economic and financial reasoning, supported by well-documented empirical evidence. These opinions are articulated through confidential reports to our clients, testimony submitted to regulators, and articles in scholarly journals.

Since 1994 E3 has been advising a number of electric utilities in their general rate case filings. We actively participate in the development of regulatory strategy, preparation of direct testimony, review of submissions by intervenors, training of witnesses, cross-examination of intervening parties, preparation of rebuttal testimonies and closing arguments.

- **Pacific Gas and Electric Company (PG&E)**. E3 advised PG&E in 1994 on the use of emission adders in marginal costing and rate design. Based on our advice, PG&E successfully argued before the California Public Utilities Commission (CPUC) that misguided application of emission cost adders could cause uneconomic bypass and defeat the purpose of environmental protection. The economic reasoning is summarized in Woo, C.K., B. Hobbs, R. Orans, R. Pupp and B. Horii (1994) "Emission Costs, Customer Bypass and Efficient Pricing of Electricity," Energy Journal, 15:3, 43-54.
- **Pacific Gas and Electric Company (PG&E)**. E3 testified in 1996 before the CPUC on the misuse of customer-class specific outage costs in developing customer-class specific marginal cost. Our testimony convinced the CPUC to reject the misuse. The testimony was based on Woo, C.K. (1988) "Optimal Electricity Rates and Consumption Externality," Resources and Energy, 10, 277-292.

Electricity Market Reform

- **Southern California Water Company (SCWC)**. SCWC retained E3 in 2001 to rebut the large disallowance of power purchase cost recommended by the Office of Ratepayers Advocate (ORA)

of the CPUC and a large user served by SCWC's subsidiary, Bear Valley Electric Service. The rebuttal testimony affirms that SCWC was prudent in signing a $95/MWH fixed price 5-year contract in March 2001, at the height of the California energy crisis. The testimony resulted in a favorable settlement for SCWC.

- **Ontario Hydro**. In 1997, Ontario Hydro (OH) retained E3 to develop its regulatory and business strategies in view of the market reform initiative in the Ontario Government's 1997 White Paper. During 1997-1998, we worked with Ontario Power Generation (OPG), the successor of Ontario Hydro's generation business, on strategic issues related to transmission pricing and access, market power mitigation and congestion management. Our advice helped OPG to develop and present its positions in the Ontario Market Design Committee.
- **Upper Canada Energy Alliance**. The Ontario Energy Board (OEB) in 1999 proposed price cap regulation for the municipal utilities that are resellers owned by city governments. E3 was the chief witness for the Upper Canada Energy Alliance of 10 large municipal utilities, and successfully defended the Alliance's positions before the OEB.
- **British Columbia (BC) Hydro**. During 1994-96, E3 assisted BC Hydro in responding to the provincial government's electricity market structure review (EMSR). Industrial customers, potential market entrants, and a commissioner of the BC Utilities Commission (BCUC) were pushing for a UK-style market reform that would establish a power pool and divest BC Hydro's vast hydroelectric assets. E3 affirmed that consumers could reap the benefits of wholesale competition via a regulatory reform that did not require market restructuring. The BCUC adopted E3's proposal and rejected market reform.
- **Israel Electric Corporation (IEC)**. Since the mid-1990s, the Israeli Government has been pushing market reform with the goal of privatizing IEC, the nationally-owned electricity monopoly. E3 is IEC's principle advisor in regulatory strategy. E3 has analyzed the effects of market reform on IEC, electricity consumers and Israel's economy. E3's research to date has discouraged the Israeli Government from adopting a market reform.
- **Hawaiian Electric Company (HECO)**. Since 1997, E3 has been HECO's advisor on regulatory and business strategies. Our advice spans asset valuation, merger, divestiture, customer bypass, distributed resources, rate design, metering and billing, and response to marker reform initiatives.

Some examples of our research on market reform are contained in:

- Woo, C.K., D. Lloyd and A. Tishler (2002) "Electricity Market Reform Failures: UK, Norway, Alberta and California," Energy Policy, forthcoming.
- Tishler, A., C.K. Woo and D. Lloyd (2002) "Reforming Israel's Electric Sector," Energy Policy, 30:4, 347-353.
- Woo, C.K. (2001) "What Went Wrong in California's Electricity Market?" Energy - The International Journal, 26:8, 747-758.
- Woo, C.K., D. Lloyd-Zannetti and I. Horowitz (1997) "Electricity Market Integration in the Pacific Northwest," Energy Journal, 18:3, 75-101.

Rate Design Opinions

- **Ontario Hydro**. E3 advised Ontario Hydro (OH) during 1994-1996 on how to price its service options, including real time pricing, interruptible and curtailable services, off-peak incremental sales, and economic development rate. These options were designed to provide customer choices and access to wholesale market prices without changing the extant regulatory regime. By taking advantage of the divergence between the regulated tariffs and the wholesale prices, the options were always profitable to OH. E3 then helped OH to prepare submissions filed with the Ontario Energy Board.
- **British Columbia (BC) Hydro**. In 1996, E3 was the witness for BC Hydro on industrial service options before the BC Utilities Commission (BCUC). Such options include real time pricing, curtailable service, and time-of-use service. The BCUC adopted E3's proposal.
- **Israel Electric Corporation (IEC)**. The IEC retained E3 in 2000 to analyze the economic efficiency and revenue collection of its industrial time-of-use (TOU) tariff. Our research shows that IEC's industrial TOU rates should be replaced by a Hopkinson tariff with demand charges that apply to a large firm's subscribed demand for generation capacity and connected load for transmission and distribution capacities. The IEC adopted E3's recommendation.

Some examples of our research on rate design are:

- Woo, C. K., B. Horii and I. Horowitz (2002) "The Hopkinson Tariff Alternative to TOU Rates in the Israel Electric Corporation," Managerial and Decision Economics, 23:9-19.
- Woo, C.K., P. Chow and I. Horowitz (1996) "Optional Real-Time Pricing of Electricity for Industrial Firms," Pacific Economic Review, 1:1, 79-92.
- Woo, C.K., R. Orans, B. Horii and P. Chow (1995) "Pareto-Superior Time-of-Use Rate Option for Industrial Firms," Economics Letters, 49, 267-272.

Stranded Cost Opinions

- **Israel Electric Corporation (IEC).** Anticipating a market reform, IEC retained in 2001 E3 to analyze the stranded cost recovery mechanisms used in the US and assess the financial performance of an incumbent utility under alternative mechanisms. The key finding was that a California-style "head-room" mechanism can easily doom the once-financially healthy utilities, Pacific Gas and Electric Company and Southern California Edison.
- **Legislature of the State of Alaska**. In 1998, the State of Alaska commissioned investigations to determine if there was clear evidence that restructuring would be in the public interest. E3 simulated the impact on all market participants of restructuring the Alaska Railbelt utilities under alternate market structure, bidder behavior, new generation entrant, transmission access and expansion, and fuel cost scenarios. E3's analysis showed that there was high risk and no compelling advantage to restructuring the Alaska Railbelt utilities. The Alaska Commission shelved further restructuring efforts.

- Central Power and Light. In 1996, E3 testified on behalf of the Texas utility regarding the levels of potential stranded costs under alternate retail access implementations. The Texas Public Utilities Commission had originally been considering open access in 1998. E3's analysis allowed the Commission to see the value of phased approach to retail access, and provided alternate methods to provide the efficiencies of "market prices" to customers without the disruption of rapid market restructuring. Texas did not open the electricity retail market until 2002.

Transmission

- **BC Hydro and Hydro Quebec**. To obtain power-marketing authorization (PMA) from the Federal Energy Regulatory Commission (FERC) in the US, Canadian utilities must file a transmission rate design consistent with the pro-forma tariff in the FERC's Order 888. E3 testified on rate design issues on behalf of BC Hydro (1996-97) and Hydro Quebec (2001) in their respective transmission tariff filings. The provincial regulators adopted the proposed designs.
- **Consolidated Edison (CECONY) and Orange and Rockland (ORU)**. E3 is the T&D planning consultant for ConEd and its subsidiary OR. E3 successfully convinced the New York Public Services Commission (NYPSC) to adopt the T&D plans of the two utilities, while satisfying the concerns raised by environmentalists and consumer groups. The NYPSC also endorses E3's integrated approach to T&D planning in a deregulated market environment.
- **Regional Transmission Organization (RTO) West**. E3 is currently a representative of BC Hydro in the RTO West's design committee on congestion management. BC Hydro is the first Canadian utility to participate directly in a US regulated wholesale market structure. E3 has successfully argued against proposals that would deny BC Hydro reasonable access to the grid owned by the filing utilities of the RTO West. E3's prior work in transmission pricing and access allows BC to continue to have its rights as a sovereign country over its bulk power system and simultaneously participate in a seamless market across the Pacific Northwest.

Some examples of our work in transmission are:

- Woo, C. K., I. Horowitz and J. Martin (1998) "Reliability Differentiation of Electricity Transmission," Journal of Regulatory Economics, 13:277-292.
- Chow, R.F., Horii, B., Orans, R. et. al. (1995), Local Integrated Resource Planning of a Large Load Supply System, Canadian Electrical Association.
- Orans, R., C.K. Woo and B. Horii (1994) "Targeting Demand Side Management for Electricity Transmission and Distribution Benefits," Managerial and Decision Economics, 15, 169-175.

- **California Energy Commission** 2000-2001. E3 is conducting research as subcontractor to Onsite Energy Corporation to evaluate the opportunities for rate unbundling to enhance the ability of distributed energy resources (DER) and demand side management (DSM) to provide transmission ancillary and supplemental services and distribution level services to California's electric power

system. The evaluation includes definition and pricing of services, and characterization of the engineering and institutional limitations of DER and DSM to provide these T&D services.

- **California Energy Commission** (1999-ongoing): E3 is working with the California Energy Commission on a potential change in the economic basis for the California Title 24 Building Energy Standards. Current standards are based on constant source energy credits that do not vary by time and area. Therefore, under the current standard energy conservation is valued equally at all times of the day and night, and in all areas of California. The study investigated a shift to a dollar-based standard which accounts for the time and geographic differences in energy costs seen in California PX prices, natural gas and propane markets, as well as in the costs of electric utility distribution and transmission systems.
- **B.C. Hydro (Canada):** 1996-Present. E3 is B.C. Hydro's principal consultant for the design of the utility's wholesale transmission service tariff which incorporates a two-part structure and the terms of the pro-forma tariff of Federal Energy Regulatory Commission (FERC). E3's findings were filed with the BCUC as prepared testimony. As a result of the tariff filed, FERC granted B.C. Hydro the Power Marketing Authorization.
- **B.C. Hydro (Canada)**, 1995-present. In 1995, B.C. Hydro retained E3 to analyze the effect of industry restructuring and the deregulation of the generation business on the bills of electricity consumers in British Columbia. As a result of this study, the British Columbia Utilities Commission (BCUC) adopted a path of gradual change, beginning with wholesale competition.
- **Central and Southwest Services (CSWS):** 1996. E3 was a regulatory witness for CSWS in their 1996 stranded cost case. E3's testimony was based on their forecast of the impact of changing regulatory structures in the electric sector on current generation plant values and the likely mix and price of new generation sources.
- **World Bank:** 1997. E3 designed a course for the World Bank titled "Electric Utility Regulatory Reporting and Accounting: Theory and Practice for Regulators". The purpose of this course is to review and discuss methods for assessing and regulating electric utility performance, with a focus on reported information. The course has since been given to regulators in Argentina.
- **Central Southwest Corporation (CSW):** 1996. E3 was retained by CSW to analyze the amount of generation investments potentially stranded by retail access. E3 applied the asset valuation and lost net revenue approaches to quantify this amount, which ranges from $1 to $3 billion depending on assumptions made about (a) future market prices; (b) pace of deregulation; and (c) sales by existing plants. The findings were presented to the Public Utilities Commission of Texas (PUCT) as direct and rebuttal testimonies. As a result of E3's participation, the PUCT recognized the size and degree of uncertainty surrounding the estimates of stranded cost. The adopted mean estimate was US$2 billion, significantly larger than the PUCT staff's original estimate of US$0.8 billion.
- **Pacific Gas and Electric Company (PG&E):** 1994. PG&E retained E3 to evaluate the financial risk of alternative formulae for performance based regulation (PBR). PBR is popular among regulators who believe it encourage cost efficiency and enhances productivity. As a result of E3's analysis, PG&E chose a relatively "safe" formula.
- **Fannie Mae:** 1992-1993. The goal of this project was to investigate whether energy efficiency lending could become a profitable new business for Fannie Mae and support its core mission for

promoting housing affordability. The argument being that reducing the monthly operating expenses of a household, by reducing its electricity bill through energy efficiency measures and appliances, would bring home ownership within the reach of more Americans. The project required an assessment of the potential market for energy efficiency loans and a survey of utilities across the country.

ENERGY RISK MANAGEMENT

E3 is an industry leader in defining standards for evaluating the profitability and risk of energy transactions. E3 has taught courses on profitability analysis to scores of utilities on behalf of the Electric Power Research Institute. E3's publications and courses demonstrate how a utility may quantify the expected margin from sales to a particular customer or customer segment using detailed information on the incremental revenue from sales and area-specific costs of serving such sales. In addition, E3's analyses translate uncertain costs and revenues into estimates of risk and return for each transaction or investment.

- **Pacific Bell:** 1997. E3 conducted an auction to procure power for Pacific Bell, one of the largest and most visible energy consumers in the California market.
- **Ontario Hydro (Canada):** 1996 – present. E3 assisted Ontario Hydro in evaluating the expected return of alternative pricing strategies in anticipation of wholesale deregulation. These strategies were developed using the Strategic Planning Model, E3's proprietary software that considers transmission constraints, capacity and load projections, and behavior of buyers and sellers.
- **Central and Southwest Services (CSWS):** 1997-Present. CSWS was one of the original clients who funded the development of E3's proprietary software Contract Evaluator. CSWS is currently using the software in the design of their RTP rates and for the evaluation of their voluntary two-part TOU rates. E3 has been retained by CSWS to provide consulting on innovative rate design, and recently gave a training course for CSWS staff in using the Contract Evaluator software for this purpose.
- **PG&E Enterprises and PG&E Energy Trading:** 1995-Present. Prior to the restructuring announcements for the California market, PG&E's affiliate hired E3 to develop a computer model to evaluate the competitive risk facing each of PG&E's industrial customers. This work helped form PG&E's strategy toward third party power projects over the following 3 years.
- **Ontario Hydro (Canada):** 1997-Present. E3 is currently advising Ontario Hydro on the development of marketing organizations. E3 provided training courses to Ontario Hydro and Ontario Municipal Electric Utilities on North American energy market and impact of deregulation. E3 also presented courses on designing customer specific marketing programs and methods of evaluating products and services offered by power marketers.

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Citizenship

United States

Professional Experience

ENERGY AND ENVIRONMENTAL ECONOMICS, INC. **SAN FRANCISCO, CA**
Senior Partner **1993- Present**

Dr. Woo specializes in public utility economics, applied microeconomics and finance. He has conducted research on electricity market reform, public utility pricing, reliability planning, demand side management (DSM) evaluation, marginal costing, and applied finance. He has testified and prepared expert testimony for use in regulatory proceedings. His current research interests include market reform and deregulation, electricity market integration and price competition, transmission pricing, electricity market price volatility and risk management, and rate option design. He has published over 50 articles on deregulation, electricity pricing, integrated resource planning, reliability planning, demand estimation, and applied finance. Recognized by *Who's Who in Science and Engineering*, Dr. Woo is an associate editor of *Energy – The International Journal* for a 3-year term of 2002-2004. He is currently a member of the editorial board of *The Energy Journal* and has served as their guest editor for a special issue on electricity reliability.

DEPARTMENT OF ECONOMICS AND FINANCE, CITY UNIVERSITY OF HONG KONG **HONG KONG**
Associate professor **1991 – 1993**

Dr. Woo analyzed the economic impacts of supply shortage on consumers, resulting in a series of publications on water and electricity rationing. He also tested the specification errors of econometric models of stock returns. As a consultant, he performed marginal costing, DSM evaluation and reliability planning which led to several publications on local integrated resource planning and T&D costing.

ANALYSIS GROUP, INC. **SAN FRANCISCO, CA**
Senior Associate **1987 – 1991**

Dr. Woo was responsible for applied microeconomics, outage cost estimation, reliability planning, and electricity pricing. He was the primary consultant to several utilities for outage cost estimation and reliability differentiation. His extensive publications in these two areas are widely cited by other researchers. He also performed economic analysis of mergers and acquisition with a primary focus on the anti-trust aspect of market power. The findings from this analysis were filed with both state and federal courts.

PACIFIC GAS AND ELECTRIC COMPANY – RATES DEPARTMENT **SAN FRANCISCO, CA**
Rate Economist **1985 – 1987**

Dr. Woo revamped PG&E's research on outage cost estimation whose findings appear in a special issue of *The Energy Journal* focusing on electricity reliability. He also participated in PG&E's preparation of the General Rate Cases.

SACRAMENTO MUNICIPAL UTILITIES DIST. - RESOURCE PLANNING DEPT. **SACRAMENTO, CA**
Econometrician **1984 – 1985**

Dr. Woo was responsible for demand estimation and load forecasting. The results from his study guided SMUD's resource planning.

PACIFIC GAS AND ELECTRIC COMPANY – RATES DEPARTMENT **SAN FRANCISCO, CA**
Rate Economist **1982 – 1984**

Dr. Woo was responsible for time-of-use (TOU) demand analysis and TOU pricing mandated by the CPUC. This work resulted in a performance award from PG&E and several publications.

CALIFORNIA ENERGY COMMISSION **SACRAMENTO, CA**
Research Assistant **1978 – 1982**

Mr. Woo was the primary author of the life cycle costing model used by the CEC to analyze solar energy and other DSM measures. He testified before the CPUC on the economics of solar financing.

Education

UNIVERSITY OF CALIFORNIA AT DAVIS **DAVIS, CA**
Ph.D. in Economics **1982**

QUEEN'S UNIVERSITY **KINGSTON, ONTARIO**
MA in Econometrics **1977**

CONCORDIA UNIVERSITY **MONTREAL, QUEBEC**
B.Comm. in Economics **1976**

LANGUAGES

Cantonese

Publications and Reports

Refereed

Applied Microeconomics

1. *Woo, C.K., D. Lloyd and A. Tishler (2001) "Electricity Market Reform Failures: UK, Norway, Alberta and California," Energy Policy, forthcoming.*

2. *Tishler, A., C.K. Woo and D. Lloyd (2002) "Reforming Israel's Electric Sector," Energy Policy, 30:4, 347-353.*

3. *Seeto, D. Q., C.K. Woo and I. Horowitz (2001) "Finessing the Unintended Outcomes of Price-Cap Adjustments: An Electric Utility Multi-Product Perspective," Energy Policy,* 29:13, 1111-1118.

4. *Woo, C.K. (2001) "What Went Wrong in California's Electricity Market?" Energy - The International Journal, 26:8, 747-758.*

5. *Hartway, R., S. Price and C.K. Woo (1999) "Smart Meters, Customer Choice and Profitable Time of Use Rate Option," Energy - The International Journal, 24, 895-903.*

6. *Woo, C.K., D. Lloyd-Zannetti and I. Horowitz (1997) "Electricity Market Integration in the Pacific Northwest," Energy Journal, 18:3, 75-101.*

7. *Woo, C.K., D. Lloyd-Zannetti, R. Orans, B. Horii and G. Heffner (1995) "Marginal Capacity Costs of Electricity Distribution and Demand for Distributed Generation," Energy Journal, 16:2, 111-130.*

8. *Woo, C.K. and R.H.F. Kwok (1994) "Vanity, Superstition and Auction Price," Economics Letters, 44, 389-395.*

9. *Woo, C.K. (1994) "Managing Water Supply Shortage: Interruption vs. Pricing," Journal of Public Economics, 54, 145-160.*

10. *Woo, C.K. and K.W.K. Lo (1993) "Factor Supply Interruption, Welfare Loss and Shortage Management," Resource and Energy Economics, 15, 339-352.*

11. *Woo, C.K. (1992) "Drought Management, Service Interruption and Water Pricing: Evidence from Hong Kong," Water Resources Research, 28:10, 2591-2595.*

12. *Hartman, R.S., M.J. Doane and C.K. Woo (1991) "Consumer Rationality and the Status Quo," Quarterly Journal of Economics, February, 141-162.*

13. *Woo, C.K., P. Hanser and N. Toyama (1986) "Estimating Hourly Electric Load with Generalized Least Squares Procedures," Energy Journal, 7:2, 153-170.*

14. *Woo, C.K. (1985) "Demand for Electricity of Small Nonresidential Customers under Time-of-Use Pricing," Energy Journal, 6:4, 115-127.*

15. *Woo, C.K. (1984) "A Note on Measuring Household Welfare Effects of Time-of-Use Pricing," Energy Journal, 5:3, 171-181.*

Applied Finance

1. *Woo, C.K., I. Horowitz and K. Hoang (2001) "Cross Hedging and Forward-Contract Pricing of Electricity," Energy Economics, 23: 1-15.*

2. *Woo, C.K., I. Horowitz and K. Hoang (2001) "Cross Hedging and Value at Risk: Wholesale Electricity Forward Contracts," Advances in Investment Analysis and Portfolio Management, 8, 283-301.*

3. *Wong, K.A., C.K. Woo and R.Y.K. Ho (1998) "Macroforecasting Accuracy and Gains from Stock Market Timing," Research in Finance, 16: 127-139.*

4. *Woo, C.K. and Y.L. Cheung (1996) "Specification Tests of A Market Model of Stock Returns," Advances in Quantitative Finance and Accounting, 4: 187-194.*

5. *Woo, C.K., A. Lai and Y.L. Cheung (1995) "Specification Tests of A Market Model of Asia-Pacific Stock Returns: Thailand and Hong Kong," Journal of Business Finance and Accounting, 22:3, 363-375.*

6. *Woo, C.K., Y.L. Cheung and R.Y.K. Ho (1994) "Endogeneity Bias in Beta Estimation: Thailand and Hong Kong," Pacific-Basin Finance Journal, 2, 453-461.*

7. *Ho, R.Y.K., Z. Fang and C.K. Woo (1992) "Intraday Arbitrage Opportunities and Price Behavior of Hang Seng Index Futures," The Review of Futures Markets, 11:3, 413-430.*

8. *Fang, Z. and C.K. Woo (1991) "Two Factor Model for Bond Selection," Economics Letters, 37, 417-421.*

Pricing Theory

1. *Woo, C. K., B. Horii and I. Horowitz (2002) "The Hopkinson Tariff Alternative to TOU Rates in the Israel Electric Corporation," Managerial and Decision Economics, 23:9-19.*

2. *Woo, C. K., I. Horowitz and J. Martin (1998) "Reliability Differentiation of Electricity Transmission," Journal of Regulatory Economics, 13:277-292.*

3. *Seeto, D.Q., C. K. Woo and I. Horowitz (1997) "Time-of-Use Rates vs. Hopkinson Tariffs Redux : An Analysis of the Choice of Rate Structures in a Regulated Electricity Distribution Company, " Energy Economics, 19, 169-185.*

4. *Woo, C.K., P. Chow and I. Horowitz (1996) "Optional Real-Time Pricing of Electricity for Industrial Firms," Pacific Economic Review, 1:1, 79-92.*

5. *Horowitz, I., D.Q. Seeto and C.K. Woo (1996) "Ramsey Pricing of Electricity under Unknown Bypass Costs," Energy Journal, 17:2, 59-77.*

6. *Woo, C.K., R. Orans, B. Horii and P. Chow (1995) "Pareto-Superior Time-of-Use Rate Option for Industrial Firms," Economics Letters, 49, 267-272.*

7. *Seeto, D.Q., S.D. He and C.K. Woo (1994) "Pricing Electric Harmonics," Energy - The International Journal, 20:7, 617-621.*

8. *Woo, C.K., B. Hobbs, R. Orans, R. Pupp and B. Horii (1994) "Emission Costs, Customer Bypass and Efficient Pricing of Electricity," Energy Journal, 15:3, 43-54.*

9. *Orans, R., C.K. Woo, R. Pupp and I. Horowitz (1994) "Demand Side Management and Electric Power Exchange," Resource and Energy Economics, 16, 243-254.*

10. *Woo, C.K. (1993) "Efficient Electricity Pricing with Self-Rationing: Reply," Journal of Regulatory Economics, 5:1, 101-102.*

11. *Woo, C.K. (1992) "Optimal Electricity Pricing and Capacity Rationing," Hong Kong Economic Papers, 22, 1-6.*

12. *Woo, C.K. (1991) "Capacity Rationing and Fixed Cost Collection," Energy Journal, 12:2, 153-164.*

13. *Woo, C.K. (1990) "Efficient Electricity Pricing with Self-Rationing," Journal of Regulatory Economics, 2:1, 69-81.*

14. *Woo, C.K. (1988) "Optimal Electricity Rates and Consumption Externality," Resources and Energy, 10, 277-292.*

15. *Woo, C.K. and D.Q. Seeto (1988) "Optimal Off-Peak Incremental Sales Rate in Electricity Pricing," Energy Journal, 9:1, 93-102.*

16. *Woo, C.K. (1988) "Inefficiency of Avoided Cost Pricing of Cogenerated Power," Energy Journal 9:1, 103-113.*

17. *Woo, C.K. and N. Toyama (1986) "Service Reliability and the Optimal Interruptible Rate Option in Residential Electricity Pricing," Energy Journal, 7:3, 123-136.*

18. *Woo, C.K. (1985), "An Application of the Expenditure Function in Electricity Pricing: Optimal Residential Time-of-Use Rate Option," Energy Journal, 6:2, 89-99.*

Planning Studies

1. *Heffner, G., C.K. Woo, B. Horii and D. Lloyd-Zannetti (1998) "Variations in Area- and Time-Specific Marginal Capacity Costs of Electricity Distribution," IEEE Transactions on Power Systems, PE-493-PWRS-012-1997, 13:2, 560-567.*

2. *Forte, V.J., R. Pupp, R. Putnam and C.K. Woo (1995) "Using Customer Outage Costs in Electricity Reliability Planning," Energy - The International Journal, 20:2, 81-87.*

3. *Pupp, R., C.K.Woo, R. Orans, B. Horii and G. Heffner (1995) "Load Research and Integrated Local T&D Planning," Energy - The International Journal, 20:2, 89-94.*

4. *Woo, C.K., R. Orans, B. Horii, R. Pupp and G. Heffner (1994) "Area- and Time-Specific Marginal Capacity Costs of Electricity Distribution," Energy - The International Journal, 19:12, 1213-1218.*

5. *Orans, R., C.K. Woo and B. Horii (1994) "Targeting Demand Side Management for Electricity Transmission and Distribution Benefits," Managerial and Decision Economics, 15, 169-175.*

6. *Orans, R., C.K. Woo and R.L. Pupp (1994) "Demand Side Management and Electric Power Exchange," Energy - The International Journal, 19:1, 63-66.*

7. *Keane, D.M. and C.K. Woo (1992) "Using Customer Outage Costs to Plan Generation Reliability," Energy - The International Journal, 17:9, 823-827.*

Cost of Electricity Rationing

1. *Woo, C.K. and R.L. Pupp (1992) "Costs of Service Disruptions to Electricity Consumers," Energy - The International Journal, 17:2, 109-126.*

2. *Woo, C.K., R.L. Pupp, R. Mango and T. Flaim (1991) "How Much Do Electricity Consumers Want to Pay for Reliability?" Energy Systems and Policy, 15, 145-159.*

3. *Hartman, R.S., M.J. Doane and C.K. Woo (1990) "Status Quo Bias in the Measurement of Value of Service," Resources and Energy, 12, 197-214.*

4. *Munasinghe, M., C.K. Woo and H.P. Chao (1988) Special Electricity Reliability Issue, Energy Journal, 9.*

5. *Goett, A.A. D. McFadden and C.K. Woo (1988) "Estimating Residential Value of Service Reliability with Market Research Data," Special Electricity Reliability Issue, Energy Journal, 9, 105-120.*

6. *Woo, C.K. and K. Train (1988) "The Cost of Electric Power Interruption to Commercial Firms," Special Electricity Reliability Issue, Energy Journal, 9, 161-172.*

7. *Doane, M.J., R.S. Hartman and C.K. Woo, (1988) "Households' Perceived Value of Electric Power Service Reliability: An Analysis of Contingent Valuation Data," Special Electricity Reliability Issue, Energy Journal, 9, 135-149.*

8. *Doane, M.J., R.S. Hartman and C.K. Woo, (1988) "Household Preferences of Interruptible Rate Options and the Revealed Value of Service Reliability," Special Electricity Reliability Issue, Energy Journal, 9, 121-134.*

9. *Keane, D.M., L.S. MacDonald and C.K. Woo (1988) "Estimating Residential Partial Outage Costs with Market Research Data," Special Electricity Reliability Issue, Energy Journal, 9, 151-159.*

Research Reports

1. *Woo, C.K. (2002) Rebuttal Testimony filed on the behalf of Southern California Water Company before the California Public Utilities Commission.*

2. *Woo. C.K. and D. Lloyd (2001) Stranded Cost Recovery in Electricity Market Reforms, report submitted to Israel Electric Corporation.*

3. *Woo. C.K. and D. Lloyd (2001) Assessment of the Peak Benefit Multiplier Effect: (a) Economic Theory and Statistical Specification; and (b) Theory, Estimation and Results, reports submitted to Pacific Gas and Electric Company.*

4. *Horii, B., C.K. Woo and D. Engel (2000) PY2001 Public Purpose Program Strategy and Filing Assistance: (a) A New Methodology for Cost-Effectiveness Evaluation; (b) Peak Benefit Evaluation; (c) Screening Methodology for Customer Energy Management Programs; and (d) Should California Ratepayers Fund Programs that Promote Consumer Purchases of Cost-Effective Energy Efficient Goods and Services? reports submitted to Pacific Gas and Electric Company.*

5. *Tishler, A., C.K. Woo and D. Lloyd (2000) Reforming Israel's Electric Sector: Choices for Change, position paper submitted to Israel Electric Corporation.*

6. *Woo, C.K. and P.D. Ferguson (1999) Comments on the Ontario Energy Board Staff's Draft Electric Distribution Rate Handbook, report submitted to Ontario Energy Board on the behalf of The Upper Canada Energy Alliance.*

7. *Woo, C.K. and K. Hoang (1999) Cross Hedging and Risk Premium, report submitted to Ontario Power Generation Inc.*

8. *Woo, C.K. and B. Horii (1999) Should Israel Electric Corporation (IEC) Replace Its Industrial Time of Use Energy Rates with A Hopkinson Tariff? report prepared for IEC.*

9. *Lloyd-Zannetti D. and C.K. Woo (1997) Wheeling Charges for Transmission Service, report prepared for Israel Electric Corporation.*

10. *Lloyd-Zannetti D. and C.K. Woo (1997) Capacity Shortage and Profitable Rate Options, report prepared for Israel Electric Corporation.*

11. *Lloyd-Zannetti, D., B. Horii, J. Martin, S. Price and C.K. Woo (1996) Profitability Primer: A Guide to Profitability Analysis in the Electric Power Industry, Report No. TR-106569, Electric Power Research Institute.*

12. *Woo, C.K. (1996) Electricity Market Integration in the Western Interconnection, prepared for British Columbia Power Exchange Corporation (Powerex).*

13. *Woo, C.K. (1996) Direct Testimony, Industrial Service Options Application, prepared for B.C. Hydro.*

14. *Woo, C.K. (1996) Rebuttal Testimony Presenting an Analysis of the Use of Class-based Value of Service for Marginal Generation Capacity Costs, filed with California Public Utilities Commission for Pacific Gas Electric Company's 1996 General Rate Case.*

15. *Woo, C.K. and R. Orans (1996) Transmission: Spot Price, Reliability Differentiation and Investment, report submitted to Ontario Hydro.*

16. *Orans, R., C.K. Woo and B. Horii (1995) Impact of Market Structure and Pricing Options on Customers' Bills, report submitted to B.C. Hydro.*

17. *Woo, C.K., L. Woo and R. Orans (1995) Rationing and Area-Specific Generation Costs, report submitted to Pacific Gas and Electric Company.*

18. *Woo, C.K., D. Lloyd-Zannetti and L. Woo (1994) Using Residual Emissions Adders in Electricity Ratemaking, report submitted to Pacific Gas and Electric Company.*

19. *Orans, R., C.K. Woo and C. Greenwell (1994) Designing Profitable Rate Options Using Area- and Time-Specific Costs, Report No. TR-104375, Electric Power Research Institute.*

20. *Orans, R. and C.K. Woo (1992) Marginal Cost Disaggregation Study, report submitted to Wisconsin Electric Power Corporation.*

21. *Orans, R., C.K. Woo, J.N. Swisher, B. Wiersma and B. Horii (1992) Targeting DSM for Transmission and Distribution Benefits: A Case Study of PG&E's Delta District, Report No. TR-100487, Electric Power Research Institute.*

22. *Pupp, R. and C.K. Woo (1991) Integrating Customer Outage Costs in Electricity Reliability Planning, report submitted to Niagara Mohawk Power Corporation.*

23. *Woo, C.K., R.L. Pupp and D. Glyer (1991) Voluntary Interruptible Pricing Program (VIPP): An Integrated Approach to Electricity Reliability Pricing, report submitted to Niagara Mohawk Power Corporation. Also in Caves, D.W. and D. Glyer (1992), Designing an Integrated Menu of Electric Service Options, Electric Power Research Institute Report TR-100523, Appendix B.*

24. *Doane, M.J., G. McCelland, W. Schulze and C.K. Woo (1990) Industrial Outage Cost Survey, report submitted to Niagara Mohawk Power Corporation.*

25. *Doane, M.J., G. McCelland, W. Schulze and C.K. Woo (1990) Residential Outage Cost Survey, report submitted to Niagara Mohawk Power Corporation.*

26. *Doane, M.J. and C.K. Woo (1988) An Analysis of Customer Subscription to PG&E's Interruptible and Curtailable Rates, report submitted to Pacific Gas and Electric Company.*

27. *Woo, C.K. (1988) Recent Contributions to Customer Outage Cost Estimation, report submitted to Israel Models Limited.*

28. *Doane, M.J. R.S. Hartman, W. Schulze and C.K. Woo (1988) Recommended Approach for Collecting Data on Outage Cost and Value of Service Reliability, report submitted to Niagara Mohawk Power Corporation.*

29. *Woo, C.K. (1987) Review of Existing NMPC Procedures for Collecting Data on Outage Cost and Value of Service Reliability, report submitted to Niagara Mohawk Power Corporation.*

30. *Woo, C.K., (1987) Recent Contributions to the Theory and Measurement of Customer Value of Service Reliability, report submitted to Niagara Mohawk Power Corporation.*

31. *Woo, C.K. (1984) Residential Time of Use Program - First and Second Semi-Annual Reports, Pacific Gas and Electric Company Reports filed with the California Public Utilities Commission.*

32. *Woo, C.K. (1983) A-20 Small Commercial Time of Use Experiment, Pacific Gas and Electric Company Reports filed with the California Public Utilities Commission.*

33. *Woo, C.K. and R. Orans (1983) Transferability of Other Utilities' Time of Use Experiments to PG&E's Service Schedule D-7, Pacific Gas and Electric Company Report filed with the California Public Utilities Commission.*

34. *Woo, C.K. (1979) Economics of Solar Financing, Order Instituting Investigation 42 Testimony submitted to the California Public Utilities Commission for the California Energy Commission.*

Conference Papers

1. *Seeto, D. and C.K. Woo (1995) "Time-of-Use Rates vs. Hopkinson Tariffs in Electricity Pricing," Rutgers University Advanced Workshop in Regulation and Public Utilities Economics, 8th Annual Western Conference, July 5-7, San Diego, California.*

2. *Seeto, D., S.D. He and C.K. Woo (1994) "Regulatory Perspectives of the Harmonics Problem: Pricing Electric Harmonics," 1994 IEEE Summer Power Engineering Society Meeting, July 24-29, San Francisco, California.*

3. *Seeto, D. and C.K. Woo (1994) "Practical Ramsey Pricing of Electricity and Customer Bypass under Regulation," Rutgers University Advanced Workshop in Regulation and Public Utilities Economics, 7th Annual Western Conference, July 6-8, San Diego, California.*

4. *Orans, R., C.K. Woo, B. Horii and R. Pupp (1994) "Estimation and Applications of Area- and Time-Specific Marginal Capacity Costs," Proceedings: 1994 Innovative Electricity Pricing, (February 9-11, Tampa, Florida) Electric Research Power Institute, Report TR-103629, 306-315.*

5. *Heffner, G., R. Orans, C.K. Woo, B. Horii and R. Pupp (1993) "Estimating Area Load and DSM Impact by Customer Class and End-Use," Western Load Research Association Conference, September 22-24, San Diego, California; and Electric Power Research Institute CEED Conference, October 27-29, St. Louis, Missouri.*

6. *Woo, C.K. (1992) "Drought Management: Service Interruption," International Conference on Economics and Government, September 1-4, Gold Coast, Australia.*

7. *Woo, C.K. (1991) "Local Electric Service Reliability as a Public Good," 14th International Association of Energy Economists (IAEE) Conference, East-West Center, Hawaii.*

8. *Keane, D.M. and C.K. Woo (1991) "Using Customer Outage Costs to Plan Generation Reliability," 14th International Association of Energy Economists (IAEE) Conference, East-West Center, Hawaii.*

9. *Woo, C.K. (1990) "Outage Costs as Design Criteria for Product Differentiation," New Service Opportunities for Electric Utilities: Creating Differentiated Products, Symposium sponsored by Electric Power Research Institute and University of California, Berkeley.*

10. *Woo, C.K. (1988) "Recent Contributions to Customer Outage Cost Estimation," Invited Lecture at Workshop on Energy Load Management, Israel Ministry of Energy and Infrastructure.*

11. *Woo, C.K., B.M. Gray and M.E. Carl (1987) "Residential Air Conditioning Load Model," 8th International Association of Energy Economists (IAEE) Conference, MIT.*

12. *Woo, C.K., (1987) "Fixed Cost Recovery under Competition in Electricity Pricing," 8th International Association of Energy Economists (IAEE) Conference, MIT.*

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Snuller K. Price

Citizenship

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Professional Experience

ENERGY AND ENVIRONMENTAL ECONOMICS, INC. — **SAN FRANCISCO, CA**
Senior Associate — **1993 - Present**

- Mr. Price's main areas of expertise is in economic evaluation of distributed resources (DR). In the last six years he has participated in dozens of case studies involving economic analysis of both building efficiency measures and distributed generation applications. His work includes analysis from both a utility perspective focused on reducing T&D investment costs through the use of DR as well as a customer perspective on reducing energy bills. His client list in T&D planning includes Electric Power Research Institute, California Energy Commission, Pacific Gas and Electric, Tennessee Valley Authority, New York State Electric and Gas, Commonwealth Edison, Orange and Rockland Utilities, PECO Energy, Central and Southwest Services, and many others.

- Mr. Price participated in the development of a profitable TOU rate option for the City of Laredo for Central Power and Light in southern Texas. This voluntary rate option was designed so that both the customer and the utility share in the resource savings when a customer reduces their peak energy consumption. Validated with a pilot program that showed overwhelming customer support, participants saved on their energy bills and CP&L improved its profitability.

- Mr. Price managed the day-to-day development of an on-line wholesale power exchange at yoEnergy.com that facilitates the wholesale power trading in the West. This exchange has developed a wholesale energy block designed to bridge the gap between the wholesale and emerging retail market in California. Market participants include Powerex, Enron, PG&E Energy Trading, Aquila, Avista, and other large wholesale energy suppliers.

- Mr. Price has developed three Electric Power Research Institute (EPRI) tools designed to improve planning in the T&D delivery business and has used each in several case studies. These tools include the DELTA model, the Remote Power Applications Model (RPAM), and the Area Investment Model (AIM) Screener. These tools allow utility T&D planners to value and make investment decisions while considering the reliability of their systems, the rate of return on the investments they are planning, and incorporate risk analysis into the investment decision.

Education

STANFORD UNIVERSITY — **STANFORD, CA**
MS in Engineering Economics Systems and Operations Research — **1997**

As a student at Stanford he was awarded a Research Assistantship to study the proposed structure of the California utility industry after deregulation.

SWARTHMORE COLLEGE — **SWATHMORE, PA**
BA in Economics and BS in Engineering — **1993**

Publications and Reports

With Robert Hartway and C.K. Woo. "Smart Meters, Customer Choice and Profitable Time of Use Rate Option," Energy-The International Journal, forthcoming, 1999.

With Debbie Lloyd-Zanetti, Brian Horii, Jennifer Martin, and C.K. Woo. " Profitability Primer: A Guide to Profitability Analysis in the Electric Power Industry," Report No. TR-106569, Electric Power Research Institute, 1996.

With Ren Orans, Brian Horii, Debbie Lloyd-Zanetti and Greg Ball. "A Summary of Area- and Time-Specific Costing: The Applications and Benefits of Disaggregated Costs," Report No. TR-106309, Electric Power Research Institute, 1996.

With John Bustard and Bill Clauhs. "Profitability and Risk Assessment of T&D Capital Expansion Plans," Proceedings from the EPRI First Annual Distributed Resources Conference Proceedings: Distributed Resources 1995: Planning for a Competitive Market, August 29-31, 1995

With Brian Horii. "Methods for Screening Grid Connected DR Technologies," Proceedings from the EPRI First Annual Distributed Resources Conference Proceedings: Distributed Resources 1995: Planning for a Competitive Market, August 29-31, 1995

"Remote Photovoltaics Application Model," Proceedings from the Electric Power Research Institute Third Annual Workshop: Advancements in Integrating DSM and Distributed Generation and Storage Into T&D Planning, June 2-3 1994

With Howard A. Walker. "Model Validation and Optimization of a Hybrid Photovoltaic-Generator System using a Modified Version of PVFORM," Proceedings from the ASME International Solar Energy Conference, Washington, D.C. April 4-9 1993.

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Brian K. Horii

Professional Experience

ENERGY AND ENVIRONMENTAL ECONOMICS, INC. **SAN FRANCISCO, CA**

Vice-President **1993 - Present**

Mr. Horii designed many of E3's software models currently being used by electric utilities across the United States and Canada, addressing such topics as: evaluation of trading decisions; estimations of utility costs; and evaluation of the economic benefit of small-scale generation assets.

Mr. Horii's practice area centers around:

- Asset Valuation and Competitive Issues. Provided an Ontario Municipal utility client with a model to determine the value of the utility to the town under alternate regulatory and economic scenarios. Assisted retail clients with development of Requests for Proposal, and provided recommendations on energy procurement and service contracts offered to those clients. Provided auction bid values for California Fossil plants under deregulation, including issues such as emission credits and potential offset costs, site land value, and historical interactions between the plants and the communities. Evaluated the impact of competition on the Alaska railbelt utilities on behalf of the Alaska Legislature. Simulated bilateral trading decisions in an open access market; analyzed market segments for micro generation options under unbundled rate scenarios; forecasted stranded asset risk and recovery for North American utilities; and created unbundled rate forecasts. Other work in the area includes: teaching courses on profitability analysis for EPRI; performing customer market segmentation studies for PG&E and Ontario Hydro; designing a comprehensive billing and information management system for a major ESP operating in California; and testifying before the British Columbia Public Utilities Commission on electric market restructuring.
- Utility Costing and Planning. Authored numerous marginal cost studies for utilities across North America. Co-authored a study for the CEC on the impacts of changing building standards to capture geographic differences in utility usage patterns and costs. Areas of expertise include estimation of area and time specific marginal costs; incorporation of customer outage costs into planning criteria, and dynamic integrated resource evaluation to determine the potential local-area benefits of targeted DSM and modular generation.

Past and present clients include: B.C. Hydro, California Energy Commission, Centerior, Central and Southwest Services, Central Power and Light Company, Commonwealth Edison, Consolidated Edison Company of New York, EPRI, Hawaii Electric Company, Israel Electric Company, Kansas City Power and Light, National Renewable Energy Laboratory, New York State Electric and Gas, Ontario Hydro, Orange and Rockland Utilities, PG&E, PG&E Energy Services, Public Service Indiana Energy, Public Service Oklahoma, Tennessee Valley Authority, and Wisconsin Electric Power Company,

PACIFIC GAS AND ELECTRIC CO. **SAN FRANCISCO, CA**

Project Manager **1993**

Managed and provided technical support to PG&E's investigation into the Distributed Utilities (DU) concept. The projects included an assessment of the potential for DU devices at PG&E, an analysis of the loading patterns on PG&E's 3000 feeders, and formulation of the modeling issues surrounding the integration of Generation, Transmission, and Distribution planning models.

PACIFIC GAS AND ELECTRIC CO. **SAN FRANCISCO, CA**

Supervisor of Electric Rates **1987 – 1993**

Served as PG&E's expert witness on revenue allocation and rate design in testimonies before the California Public Utilities Commission (CPUC). Was instrumental in getting PG&E's area-specific loads and costs adopted by the CPUC. and extending their application to cost effectiveness analyses of DSM programs. Additional analytical work included creating interactive negotiation analysis programs, and forecasting electric rates trends for short-term planning.

INDEPENDENT CONSULTING **SAN FRANCISCO, CA**
1989 – 1993

Helped developed methodology for evaluating the cost-effectiveness of decentralized generation systems for relieving local distribution constraints, and created a model for determining the least cost expansion of local transmission and distribution facilities integrated with area-specific DSM incentive programs. Co-authored The Delta Report for PG&E and EPRI which examined the targeting of DSM measures to defer the expansion of local distribution facilities.

U.S. ENVIRONMENTAL PROTECTION AGENCY **SAN FRANCISCO, CA**
Environmental Engineer **1986**

Assessed and prioritized hazardous waste site inspections, developed procedures for locating potential hazardous waste sites, and created a simplified framework to allow EPA staff to interpret and apply complex Federal regulations.

CITY OF PALO ALTO ENERGY SERVICES PROGRAM **PALO ALTO, CA**
Energy Analyst **1984 - 1986**

Helped design numerous DSM programs, analyzed the engineering and economic performance of solar energy projects, estimated the thermal performance of residential and commercial buildings, helped present residential and small-commercial energy workshops, and performed on-site energy surveys.

Education

STANFORD UNIVERSITY **PALO ALTO, CA**
MS in Civil Engineering and Environmental Planning **1987**
BS in Civil Engineering

Publications and Reports

Refereed Papers

Chow, R.F., Horii, B., Orans, R. et. al. (1995), Local Integrated Resource Planning of a Large Load Supply System, Canadian Electrical Association.

Woo, C.K., R. Orans, B. Horii and P. Chow (1995), "Pareto-Superior Time-of-Use Rate Options for Industrial Firms," Economics Letters, forthcoming.

Woo, C.K., B. Hobbs, Orans, R. Pupp and B. Horii (1994), "Emission Costs, Customer Bypass and Efficient Pricing of Electricity," Energy Journal, 15:3, 43-54.

Pupp, R., C.K.Woo, R. Orans, B. Horii, and G. Heffner (1995), "Load Research and Integrated Local T&D Planning," Energy - The International Journal, 20:2, 89-94.

Woo, C.K., R. Orans, B. Horii, R. Pupp and G. Heffner (1994), "Area- and Time-Specific Marginal Capacity Costs of Electricity Distribution," Energy - The International Journal, 19:12, 1213-1218.

Orans, R., C.K. Woo and B. Horii (1994), "Targeting Demand Side Management for Electricity Transmission and Distribution Benefits," Managerial and Decision Economics, 15, 169-175.

Research Reports and Filed Testimony

B. Horii, J. Martin, K. Rabago, T. Feiler (1999), Study of Electric Utility Restructuring in Alaska, Report submitted to The Alaska Public Utilities Commission and the Alaska State Legislature.

B. Horii, J. Martin, Khoa Hoang, (1996), Capacity Costing Spreadsheet: Application of Incremental Costs to Local Investment Plans, Report and software forthcoming from the Electric Power Research Institute.

Lloyd-Zanetti, D., B. Horii, J. Martin, S. Price, and C.K. Woo (1996), Profitability Primer: A Guide to Profitability Analysis in the Eletctric Power Industry, Report No. TR-106569, Electric Power Research Institute.

Horii B., (1996) Customer Reclassification Study, Report Submitted to Ontario Hydro.

Horii, B., Orans, R., Woo, C.K., (1995) Area- and Time- Specific Marginal Cost and Targeted DSM Study, Report submitted to PSI Energy.

Horii, B., Orans, R., Woo, C.K., (1995) Local Integrated Resource Planning Study - White Rock, Report submitted to B.C. Hydro.

Horii, B., Orans, R., Woo, C.K., (1995) Area- and Time- Specific Marginal Cost Study, Report submitted to B.C. Hydro.

Orans, R., C.K. Woo and B. Horii (1995), Impact of Market Structure and Pricing Options on Customers' Bills, Report submitted to B.C. Hydro.

Horii, B., R. Orans (1995), System Incremental Cost Study 1994 Update (With Regional Results Appendix), Report number ISSN-1201-8104

Horii, B., Orans, R., Woo, C.K., (1994) Marginal Cost Disaggregation Study, Report submitted to PSI Energy.

Horii, B. (1996) System Incremental cost Study 1995 Update, Report submitted to B.C. Hydro.

Orans, R., C.K. Woo, J.N. Swisher, B. Wiersma and B. Horii (1992), Targeting DSM for Transmission and Distribution Benefits: A Case Study of PG&E's Delta District, Report No. TR-100487, Electric Power Research Institute.

Horii, B., (1991) Pacific Gas and Electric Company 1993 General Rate Case Application (eight exhibits within Phase I, and contributions to five exhibits within Phase II), A. 91-11-036, Submitted to the California Public Utilities Commission

Horii, B., (1991) Pacific Gas and Electric Company 1991 Electricity Cost Adjustment Clause Application (Revenue Allocation and Rate Design), Submitted to the California Public Utilities Commission

Conference Papers

Horii, B., (1995), "Final Results for the NMPC Area Costing and Distributed Resource Study," Proceedings Distributed Resources 1995: EPRI's First Annual Distributed Resources Conference, Electric Research Power Institute, August 29-31, 1995, Kansas City, Missouri

Orans, R., C.K. Woo, B. Horii and R. Pupp, (1994), "Estimation and Applications of Area- and Time-Specific Marginal Capacity Costs," Proceedings: 1994 Innovative Electricity Pricing, (February 9-11, Tampa, Florida) Electric Research Power Institute, Report TR-103629, 306-315.

Heffner, G., R. Orans, C.K. Woo, B. Horii and R. Pupp (1993), "Estimating Area Load and DSM Impact by Customer Class and End-Use," Western Load Research Association Conference, September 22-24, San Diego, California; and Electric Power Research Institute CEED Conference, October 27-29, St. Louis, Missouri.

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Rouslan Karimov

Citizenship

Kazakhstani
Authorized to work in the US.

Professional Experience

ENERGY AND ENVIRONMENTAL ECONOMICS, INC. — **SAN FRANCISCO, CA**
Sr. Policy Analyst — **September 2001 - Present**

· Performs statistical analysis, electricity market price and load forecasting

· Research on various energy-related topics: distributed generation, two-part tariff options for utility clients, environmental permits and regulations, statistical forecast of demand and prices.

· Assists in writing and editing final reports to clients

THE EASTWEST INSTITUTE — **PRAGUE, CZECH REPUBLIC**
Summer Intern, Transfrontier Cooperation Project — **Summer 2000**

· Researched the economic and political situation in the Kaliningrad Region, Russia.

· Wrote a draft report on Kaliningrad for an upcoming investors' conference.

SKADDEN, ARPS, SLATE, MEAGHER & FLOM LLP — **NEW YORK, NY**
Legal Assistant, Mergers & Acquisitions — **1997 – 1999**

· Assisted attorneys with document handling, including proofreading and distributions.

· Researched topics on Lexis/Nexis and on the Web.

UNITED NATIONS MISSION IN KAZAKHSTAN — **ALMATY, KAZAKHSTAN**
Translator/Interpreter — **June 1997 – December 1997**

· Performed consecutive and simultaneous interpreting during meetings and seminars.

· Translated texts on economics, law and the environment.

· Assisted project coordinators with economic analysis.

VASSAR COLLEGE, THE RUSSIAN DEPARTMENT — **POUGHKEEPSIE, NY**
Russian Language Fellow — **1995 -1997**

· Conducted Russian language conversation hours.

· Taught an Independent Study Course (Advanced Introductory Russian).

THE WORLD BANK, CASE-BY-CASE PRIVATIZATION PROGRAM — **ALMATY, KAZAKHSTAN**
Project Translator/Interpreter — **Summer 1994**

· Translated texts and interpreted during meetings.

· Assisted in interpreting balance sheets and drafting documents.

Education

PRINCETON UNIVERSITY — **PRINCETON, NEW JERSEY**
Woodrow Wilson School of Public and International Affairs
Master of Public Affairs, Economics and Public Policy — **June 2001**

VASSAR COLLEGE **POUGHKEEPSIE, NY**

Bachelor of Arts, Economics **June 1996**

Cum Laude

Other

LANGUAGES

Native knowledge of Russian

HONORS

Omicron Delta Epsilon, the International Honor Society in Economics, inducted May 1996.

National Dean's List, 1995

SPECIAL SKILLS

Quantitative: Graduate level training in economics and econometrics.

Computer: Extensive experience with STATA; financial modeling in Excel; advanced Word and WordPerfect; intermediate HTML programming, Unix and web domain management.